

**REMARKS**

Claims 8, 10, 11 and 13-16 are pending in this application. Claims 14-16 are currently withdrawn. By this Amendment, claims 8, 10 and 14 are amended and claims 9 and 12 are canceled. No new matter is added. Support for the claim amendments can be found in the original specification and claims. For example, claim 8 is amended to recite the limitations of canceled claim 9, and support for amended claim 14 is found in the Abstract.

I. **Election/Restriction**

Applicants appreciate the Examiner's acknowledgement of the Response to Restriction Requirement filed on May 17, 2006 with traverse.

It is respectfully submitted that the subject matter of all of the claim groups share the common feature of being directed to methods of manufacturing a silicon single crystal or a silicon wafer. For example, at least claims 8, 10, 11 and 13-15 share a common feature. Claims 8, 10, 11 and 13 are directed to methods of manufacturing a silicon single crystal by Czochralski method without performing Dash Necking method, and claims 14-15 are directed to a silicon single crystal grown by Czochralski method without performing Dash Necking method. Claim 14 has been amended to more clearly recite the method by which the silicon single crystal is grown. The claims are directed to the method and the product, and are not made in a materially different manner.

Applicants respectfully request reconsideration and withdrawal of the Restriction Requirement.

II. **Rejection Under 35 U.S.C. §112, second paragraph**

Claims 9-10 and 12-13 were rejected under 35 U.S.C. §112, second paragraph as allegedly being indefinite. This rejection is respectfully traversed.

The Patent Office alleged that claim 9 was unclear in scope because it recites the method of manufacturing the silicon single crystal using the Dash Necking method. Applicants respectfully disagree.

Claim 8 has been amended to incorporate the limitations of claim 9. Claim 8 recites that the seed crystal is brought into contact with the silicon melt and immersed therein with setting a temperature of the silicon melt when bringing the tip end of the seed crystal into contact with the silicon melt to 10-20°C higher than a temperature for bringing the seed crystal into contact with the silicon melt in a method of manufacturing a silicon single crystal using Dash Necking method.

The language "using Dash Necking method" in claim 8 is recited as a reference point for setting a temperature of the silicon melt when bringing the tip end of the seed crystal into contact with the silicon melt. The temperature is set 10-20°C higher than a temperature for bringing the seed crystal into contact with the silicon melt in a method of manufacturing a silicon single crystal using Dash Necking method, and does not mean that the claimed method actually uses the Dash Necking method - this alternative method is referenced solely with regard to setting a temperature in the claimed method. Claim 8 is a method of manufacturing a silicon single crystal by Czochralski method without performing Dash Necking method.

The Patent Office alleges that there is no basis for "the temperature is set 10-20°C higher than" because there no temperature condition to attribute the limitation. However, as indicated above, the temperature is set 10-20°C higher than a temperature for bringing the seed crystal into contact with the silicon melt in a method of manufacturing a silicon single crystal using Dash Necking method. For example, a temperature of the silicon melt set in performing Dash Necking method in using standard Czochralski method can be identified as  $T_d$  and the temperature in the present application identified as  $T$ . Thus, the silicon melt of the present claims is  $T > T_d$  by 10-20°C. That is, the basis for the higher temperature is the

temperature used in modifying a silicon single crystal using a Dash Necking method, and thus the temperature is set 10-20°C higher than the temperature in Dash Necking method as recited in amended claim 8.

For the foregoing reasons, Applicants respectfully submit that the rejection under 35 U.S.C. §112, second paragraph is overcome. Reconsideration and withdrawal of this rejection are respectfully requested.

III. Rejection Under 35 U.S.C. §103(a)

A. Iino in view of Sonoda

Claims 8 and 11 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 6,197,108 (hereinafter Iino) in view of U.S. Patent No. 5,911,823 (hereinafter Sonoda). This rejection is respectfully traversed.

Iino discloses a method of manufacturing a silicon monocrystal in accordance with the Czochralski method in which a seed crystal is brought into contact with silicon melt and is then slowly pulled while being rotated in order to grow a silicon monocrystalline ingot below the seed crystal (see the Abstract). Nowhere does Iino teach or suggest the temperature variation at a surface of the silicon melt is kept at  $\pm 5$  °C or less at least for a period from a point of bringing the tip end of the seed crystal into contact with the silicon melt to a point of shifting to pull the single crystal as recited in claim 8.

Moreover, Iino fails to teach or suggest setting a pulling rate to 0.5 mm/min. or less when forming a decreasing diameter portion for a period from a point immediately after shifting to pulling as in the present application.

In the present application, setting a pulling rate to 0.5 mm/min. or less when forming a decreasing diameter portion solves problems such as the diameter of the crystal being grown below the seed crystals and becoming much smaller than a desired diameter, or separation of the crystal from the silicon melt (see page 19, lines 17-24 of the present specification).

Nowhere does Iino teach or suggest that a single crystal is pulled with setting a pulling rate to 0.5 mm/min. or less when forming a decreasing diameter portion for a period from a point immediately after stopping lowering of the seed crystal and shifting to pulling to a point of starting enlargement of a diameter of the crystal formed below the seed crystal.

The Patent Office relied upon Sonoda as allegedly teaching the temperature variation of the silicon melt. Sonoda discloses a method for pulling a <110> single-crystal silicon by means of a Czochralski method for preventing the crystal from being cut in diameter-reducing (see claim 1 and the Abstract).

Even if Iino were to have been combined with Sonoda as alleged by the Patent Office, the presently claimed subject matter still would not have been achieved, at least because Sonoda does not remedy the deficiencies of Iino. Specifically, nowhere does Sonoda teach or suggest a pulling rate to 0.5 mm/min. or less when forming a decreasing diameter portion for a period from a point immediately after stopping lowering of the seed crystal and shifting to pulling to a point of starting enlargement of a diameter of the crystal formed below the seed crystal.

For all the foregoing reasons, Applicants respectfully submit that Iino and Sonoda, alone or in combination, would not have led one of ordinary skill in the art to the present claims. Reconsideration and withdrawal of this rejection are respectfully requested.

B. Iino in view of Sonoda in view of Sakurada in view of Abe

Claims 9-10 and 12-13 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Iino in view of Sonoda in further view of U.S. Patent 6,913,646 (hereinafter Sakurada) in further view of U.S. Patent 5,911,822 (hereinafter Abe). This rejection is respectfully traversed.

For all the same reasons as stated above, Iino and Sonoda fail to teach or suggest the claims of the present application.

The Patent Office relied upon Sakurada and Abe as allegedly teaching pulling rates of 0.5 to .02 mm/min. Even if Iino and Sonoda were to have been combined with Sakurada and Abe as alleged by the Patent Office, the presently claimed subject matter still would not have been achieved, at least because Sakurada and Abe do not remedy the deficiencies of Iino and Sonoda.

Sakurada discloses making a growth rate of a silicon single crystal higher than 0.5 mm/min. However, Sakurada is a method of manufacturing a silicon single crystal using a standard Czochralski method performing Dash Necking method. In addition, a growth rate of 0.5 mm/min. described in Sakurada is a growth rate of the crystal in a cylindrical silicon ingot after performing Dash Necking method (see col. 10, lines 1-68).

In the present application, the pulling rate is for a period from a point immediately after stopping lowering of the seed crystal and shifting to pulling to a point of starting enlargement of a diameter of the crystal formed below the seed crystal in using Czochralski method without performing Dash Necking method. Nowhere does Sakurada disclose setting a pulling rate to 0.5 mm/min. or less for a period from a point immediately after stopping lowering of the seed crystal and shifting to pulling to a point of forming a decreasing diameter portion as recited in the present claims.

Abe discloses a method of manufacturing a silicon monocrystal using the Czochralski method wherein a seed crystal is slowly pulled upwardly in order to grow a silicon monocrytalline ingot having a desired diameter without performing necking operation. Nowhere does Abe teach or suggest a pulling rate when forming a decreasing diameter portion for a period from a point immediately after stopping lowering of the seed crystal and shifting to pulling to a point of starting enlargement of a diameter of the crystal formed below the seed crystal, and thus does not teach or suggest setting a pulling rate to 0.5 mm/min. or less as in the present claims.

Moreover, none of the references teach or suggest a temperature of the silicon melt when bringing the tip end of the seed crystal into contact with the silicon melt. In the present application, bringing the tip end of the seed crystal into contact with the silicon melt to 10-20°C higher than a temperature for bringing the seed crystal into contact with the silicon melt in a method of manufacturing a silicon single crystal using Dash Necking method produces especially remarkable effects such as solving problems associated with a method of manufacturing a silicon single crystal using Dash Necking method. For example, if the temperature of the silicon melt is lower than a temperature appropriate to contact the seed crystal with the silicon melt, or in the case that even though higher, the difference is less than 10°C, when the seed crystal is dipped into the silicon melt, the dipped portion cannot be smoothly melted into the silicon melt, and thus results in bringing about anomalous crystal growth including solidification. Further, if the temperature of the silicon melt is over 20°C higher than a temperature appropriate to contact the seed crystal with the silicon melt, the tip end is melted before the seed crystal is brought into contact with the silicon melt, making it unable to successfully bring the seed crystal into contact with the silicon melt (page 17, line 16 to page 18, line 10 of the specification).

None of the references teach or suggest setting a temperature of the silicon melt when bringing the tip end of the seed crystal into contact with the silicon melt to 10-20°C higher than a temperature for bringing the seed crystal into contact with the silicon melt in a method of manufacturing a silicon single crystal using Dash Necking method.

For all the foregoing reasons, Applicants respectfully submit that Iino, Sonoda, Sakurada and Abe, alone or in combination, would not have led one of ordinary skill in the art to the present claims. Reconsideration and withdrawal of this rejection are respectfully requested.

IV. Rejoinder

Applicants submit that upon allowance of claims 8, 10, 11 and 13, claims 14-16 should be rejoined with the application and similarly allowed.

V. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 8, 10, 11 and 13-16 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,



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